Appendix C. Care and Handling of HEPA Filters[1]

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High reliance can be placed on the HEPA filter if precautions are taken in handling, storage, and installation. Inspection upon delivery, upon withdrawal from stock, and before and after installation is important. A filter unit should be inspected each time it is handled to guard against installation of a damaged item.

The precautions and recommendations in this handbook are based upon field experience and current development.

C.1 PACKAGING AND SHIPPING

Packaging practice varies among the filter unit manufacturers. Normally, units are packaged in cardboard cartons with various means of providing internal strengthening and impact resistance of the carton. A carton will usually contain one of the larger units, such as the 1000-cfm, $24 \times 24 \times 11\ ^{1}/_{2}$ in. unit; or it may have two 500-cfm, $24 \times 24 \times 5\ ^{7}/_{8}$ in. units. The smaller sizes, the 50-cfm, $8 \times 8 \times 5\ ^{7}/_{8}$ in., and the 25-cfm, $8 \times 8 \times 3\ ^{1}/_{16}$ in. units, frequently are packaged in multiple.

When a filter is placed in the carton, it is inserted so that the pleated folds are vertical to prevent damage in shipment. To prevent sagging of the pleats, vertical positioning of the pleats must be maintained during subsequent handling and storage. Moreover, filter units should also be installed vertically for operation.

The shipping carton is marked with a vertical arrow and the notation "this side up" to indicate positioning of the carton in the transport vehicle. Other markings, "handle with care," "use no hooks," etc., may be found on some containers.

When a filter unit is shipped with pleats in the horizontal position, the vibration that occurs during transportation and the jarring that usually accompanies handling often cause the filter medium to split or to break at the adhesive line, which will appear as a hairline crack.

Occasionally a filter unit is positioned improperly in the container by the manufacturer. Cartons frequently are not placed in railroad cars or trucks according to the vertical arrow, and they are not handled consistently with the care designated. Consequently, inspection to verify that filters have been packed properly is necessary upon delivery at destination.

C.2 INSPECTION AND TEST

Inspection starts when a delivery of filter units reaches the purchaser, even while the load is still aboard the carrier. As the shipment is being unloaded, each carton should be inspected for external damage and improper positioning in the cargo space (carton placed with arrow directed horizontally). Damaged cartons, including those with corners dented and those improperly oriented in the truck, should be set aside for particularly careful inspection of their contents. Damage will be more prevalent when filter units are loaded with mixed cargoes or are shipped in a partially loaded carrier.

The filter unit must be removed carefully from its carton. The acceptable method for removal is to open the top flaps of the container after removing the sealing tape. With flaps folded back, the carton should be inverted or upended gently to place the exposed end of the filter unit on a flat surface, preferably the floor. The surface must be clear of nuts, bolts, and similar protrusions. Then withdraw the carton from the filter unit. Attempts to remove the filter unit from the carton by grasping below the exposed filter case can result in irreparable damage if fingers puncture the delicate filter medium attached immediately below the case.

When visual inspection is made, a strong lamp should be used to examine the exposed areas of both faces to ensure that no breaks, cracks, or pinholes are evident. In addition, a less intense light, such as a

1. Updated from H. Gilbert and J. H. Palmer, *High Efficiency Particulate Air Filter Units*, USAEC Report TID-7023, August 1961.

flashlight, can be used in a darkened room. The inspector should look for visible defects with the light projected along the full length of each channel created by the separators.

Translucent spots will likely prove to be variations in thickness of the filter medium which occur during manufacture. Breaks or cracks in the medium usually show up on the surface edges of the filter pleats but often are not readily detected. Minor cracks can be of major importance. If the filter unit is installed with this pleat-edge damage, the cracks can be extended by air movement through the unit. After examining each channel, the inspector should examine the adhesive seal around the filter unit face to be sure that the seal is complete and unbroken. When one face of the filter unit has been inspected, the other face should be examined in the same manner and with the same care.

After the inspector has completed a thorough scrutiny of both faces, he should check the corner joints of the frame for adhesive sealing and tightness. Gasketing about the edge of the frame should be inspected for tight mating of gasket strips and good physical condition. Gasket strips should also be examined for full adhesion to the frame.

Cartons showing damage or dented corners and those that are found loaded in improper position upon delivery and that were set aside after being unloaded from the carrier, require careful inspection. The filter unit should be examined at all corners and particularly at the point of carton impact for damage to separators and medium. Exterior damage to several protruding separator edges in a small area will not influence filter unit efficiency if the medium is not mashed, punctured, or broken. Even though the medium may not be broken on one face, damage may occur at the opposite edge of the pleat on the other face. Large areas of mashed separator edges, even though the medium is not damaged, will obstruct the passage of air through the filter unit and thus reduce its life. Improperly stowed filter units should be inspected particularly for cracks alongside the adhesive seal, for extreme sags in pleats and separators, and for slits or breaks in the medium. The procedures outlined above, including examination with lamp and flashlight, should be used for routine inspections.

Repair of a damaged filter unit, particularly the medium, should not be attempted by the user. Any repaired unit must be retested by DOP penetrometer to ensure that hidden damage does not exist which will reduce filtering efficiency. Repair and retest thus become uneconomical for most users.

Materials used in construction of the filter unit must comply with the purchase specification, if any. Compliance, so far as practicable, should be determined at the time of inspection. Filter units that have been inspected and found damaged, defective, or not in conformance with the purchase order should be separated from acceptable units; identified; and, accompanied by necessary records, referred to the purchasing, receiving, or other appropriate department for proper disposal.

Visual inspection of the filter unit to detect physical damage is necessary. Inspection, however, is not a substitute for DOP testing with a penetrometer.

Prior to delivery, efficiency testing of the filter unit by an ERDA Quality Assurance Station is advisable. Such testing will readily disclose a defective filter unit, even when faults in the unit cannot be found by visual inspection. High penetration due to faults results in an excessive release of particles to the atmosphere. The penetrometer also measures the pressure drop, or resistance of the filter unit to the rated airstream. Excessive resistance will shorten the period that the filter unit can be used. Resistance, like penetration, must not exceed a predetermined level.

Standard practice for manufacture of HEPA filters requires that the manufacturer's test results of airflow, penetration, and resistance be marked on the case of the filter unit. These will be found in a stamp that bears the manufacturer's name, or vendor's name, together with the model number and serial number of the filter unit. Penetration and resistance should not be greater than specified by the purchase order. If not specified, penetration should not exceed 0.03% and resistance should not be more than 1.0 in.wg at rated airflow.

C.3 SHIPPING

HEPA filters should be shipped under controlled conditions insofar as practicable. Too often, after the cartons have been carefully arranged in a truck-trailer body, the shipper removes them at an interchange station, stacks them temporarily in the terminal (under completely uncontrolled conditions), and then stacks them into another truck-trailer. Handling under such conditions is usually careless, and attention to proper orientation of the cartons may be nonexistent. As a minimum, it is recommended that cartons be steel-banded to a skid or pallet, no more than $6\frac{1}{2}$ ft high, in the specified vertical orientation. Skids (pallets) must not be stacked one above the other unless bracing is provided in the truck-trailer body or railroad car to

prevent the weight of the upper load from resting on the lower. This will force the shipper to keep the cartons in their proper orientation and prevent him from throwing or dropping them indiscriminately.

Another control is to require that the filters be packed properly in a sealed truck-trailer body or in a sealed containerized-freight unit, not to be opened until arrival at the specified delivery point. The trailer or containerized-freight unit should be unloaded by personnel employed at the delivery site who have been thoroughly instructed in the proper care and handling of HEPA filters. Mixed-load shipments should be avoided.

C.4 STORAGE

Following receipt and inspection, the filter unit should be repacked carefully in the carton in which it was shipped and received. All packing material for internal strengthening of the carton and for protection of the filter unit should be replaced properly. Pleats of the filter unit should be positioned to conform to the orientation marking on the carton; this should be done routinely whether the filter unit will be installed at an early date or whether it will be stored.

Cartons of filter units should be positioned in storage to conform to the vertical arrow, and manufacturer's recommendations for storage heights should be followed. When recommendations are not available, filter units 24 × 24 × 11 ½ in. and 24 × 24 × 5 ⅞ in. should be stacked not more than three filter units high.

Mixing other items and materials with filter units in storage should be avoided to prevent damage to the filter units. Recommended aisle widths consistent with good warehousing practice should be provided to reduce damage of filter units from materials-handling equipment and other traffic. Filter units should not be stored in locations where they will be exposed to dampness, excessive heat or cold, or rapidly changing temperatures.

C.5 HANDLING

Mechanical warehousing equipment is recommended for handling large quantities of filter units. Skids and pallets should be used to provide a flat bed for movement of the units. Chains, slings, and hooks obviously must not be used. The cartons should be placed on the pallet so that the arrow on the carton points vertically.

In physically handling a packaged filter unit, a person must make certain that the carton is picked up at opposite corners and deposited carefully on the floor or other surface. The carton should not be dropped or jarred. Any filter unit dropped, whether or not in the carton, should be reexamined for damage as prescribed in Sect. C.2.

When a filter unit is lifted, it must be grasped only along the outer surface of the case. Even slight contact of fingers at almost any point within the case can puncture the filter medium.

A handle or grip is sometimes attached permanently to the wood filter frame for ease of installation and removal of the filter unit. In such instances, care must be taken in attaching the handle. Screws should not be pounded for starting, and nails should never be used. The recommended method is to drill starting screw holes, making certain that the drill and the length of screws do not penetrate through the frame and pierce the filter medium attached (screws must not be longer than ¾ in.). Pounding may crack the filter medium and possibly loosen the adhesive seal that bonds the filter pack within the frame. Attachment of a handle to a metal-frame filter unit is not recommended.

Filter units should be kept in shipping cartons when moved from one location to another. When transferred for installation, the units should be unloaded at a point which, so far as practicable, will reduce physical handling. Filter units should remain in cartons until ready for installation and then should be unpacked as prescribed in Sect. C.2.

If for any reason an unpackaged filter unit must be placed with its face on the floor or other surface, the surface must be cleared of every object or irregularity that might damage the filter pack.

C.6 INSTALLATION

Craftsmen responsible for installation of the filter unit must be carefully instructed in proper handling technique. They should know that the filter pack within the frame is delicate and must not be damaged during installation. Equally important is that the filter unit must be installed so that unfiltered air will not leak past the unit. The following installation procedure should be used:

1. Carefully remove filter unit from shipping carton, following the procedure described under Sect. C.2.

2. Carefully inspect both faces of the filter unit for cracks in the filter medium, for damage of separators, and for separation of the filter pack at the frame.

3. Ensure that the gasket is cemented firmly to the frame and that the gasket pieces are butted or mated at the joints.

4. The gasket must be compressed firmly. Compression should be applied evenly and equally at all points in increments of 5 ft-lb or less, with the filter frame completely covering the opening.

5. Install the filter with pleats and separators in the vertical position. This will eliminate sagging of pleats from accumulated weight of materials stopped by the filter unit.